Aug. 17, 1943. T. F. THOMPSON 2,326,901

HOT AIR ENGINE

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FIG. 1.

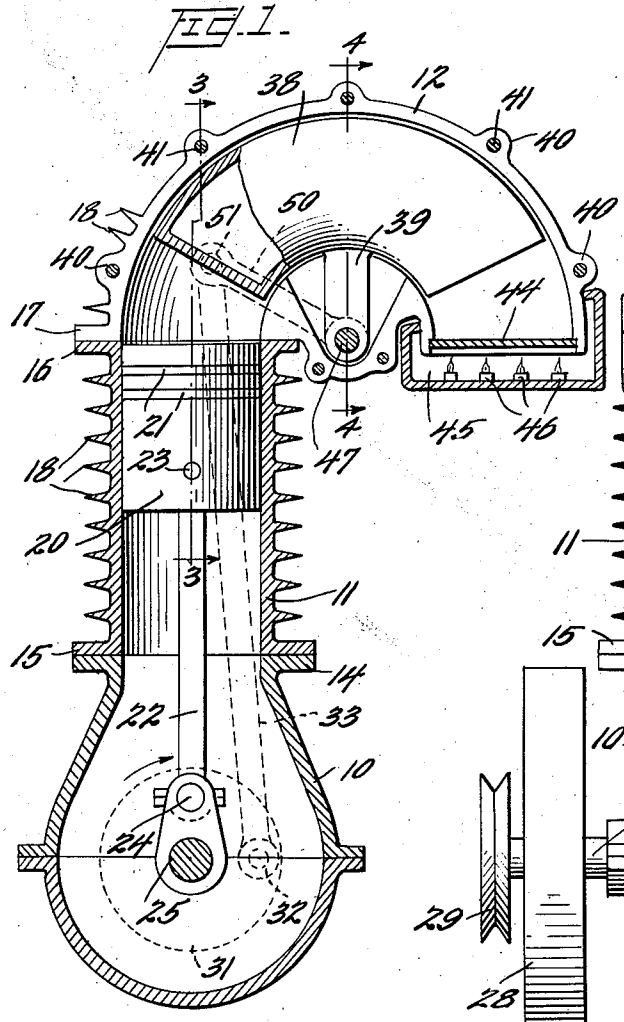

FIG. 2.

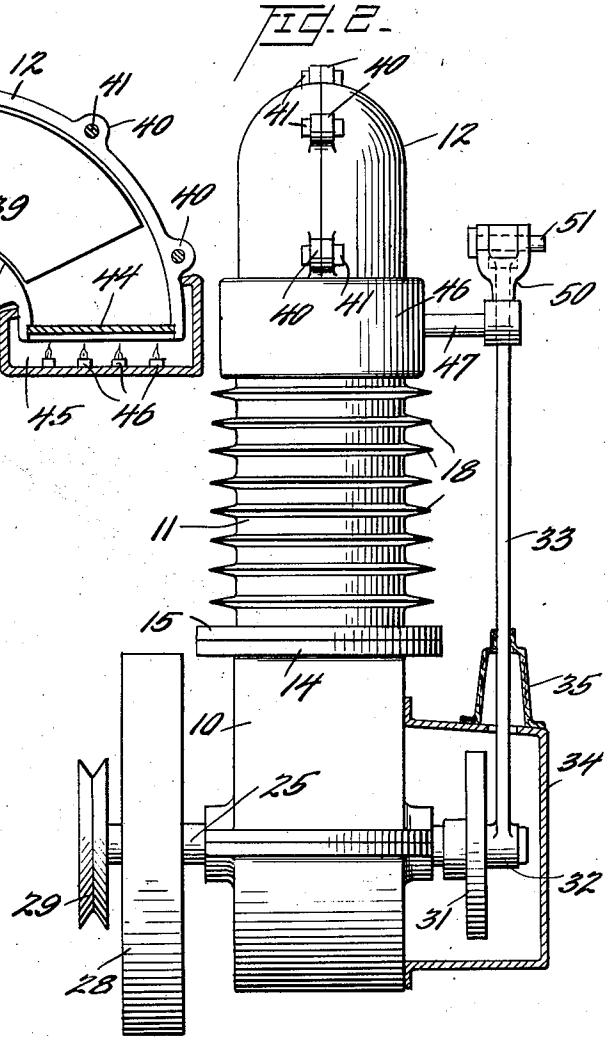

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FIG. 3.

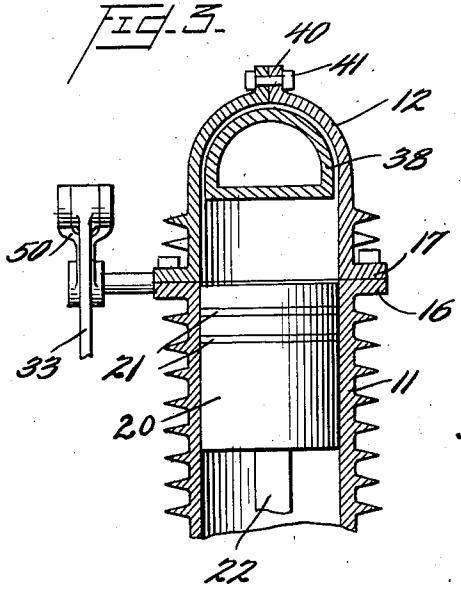


FIG. 4.

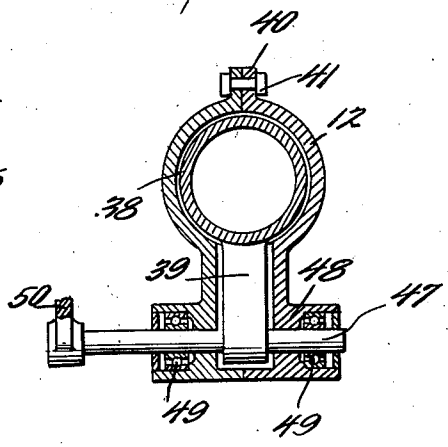
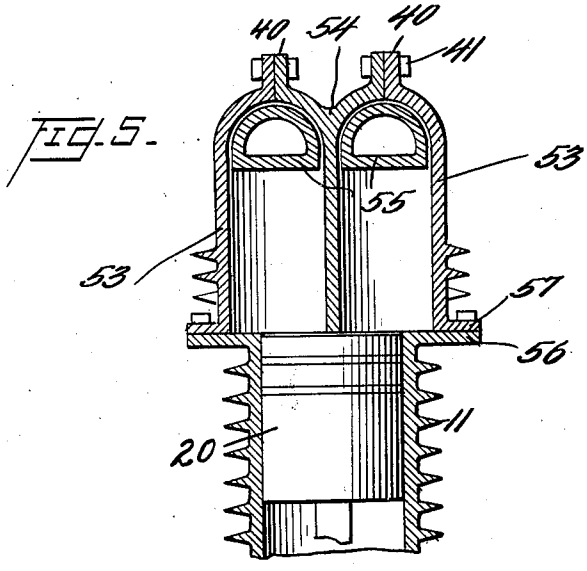


FIG. 5.



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2,326,901

HOT-AIR ENGINE

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Application October 7, 1940, Serial No. 360,161

3 Claims. (Cl. 60—24)

This invention relates to improvements in hot air engines and the like, for example, engines of the so-called Ericsson type, in which the temperature of a gaseous medium is raised in one cylinder, referred to as the heating cylinder, and is then transferred to a second cylinder in which it is expanded and cooled, known as the working cylinder. A working piston is operated by the expanding medium in the working cylinder, and a second piston, herein referred to as a transfer piston, serves to displace the gaseous medium from one cylinder to the other. The transfer piston is ordinarily driven from, but out of phase with, the working piston.

It is one of the objects of the present invention to provide a heating cylinder and a cooling cylinder formed continuously as in the Ericsson type hot air engine, but so arranged that the source of heat is not located below the cooling cylinder.

Heretofore hot air engines of the Ericsson type comprised a single cylinder, or two coaxially disposed cylinders, containing both the transfer and working pistons. The cylinder was often arranged in a vertical position with a source of heat applied at the lower end and a water jacket at the upper end. In the present invention it is proposed to reverse the cylinder so that the cooling or working cylinder is below and the heating cylinder above, the heating cylinder having an arcuate configuration, so that the heat is applied not below but to one side of and some distance away from the cooling cylinder. This has many advantages; for example, the cooling cylinder may now be provided with fins instead of the more cumbersome water jacket, necessitating a circulating means and a water supply. Further, the arrangement of the pistons was usually such that the connecting rod of the transfer piston passed through the working piston, thus reducing the working surface of the latter and increasing the friction loss.

It is another object of the invention to provide a crank case which allows the crankshaft, connecting rods, and working piston to operate in an oil bath. Heretofore, in engines of this type the working piston, connecting rods, and bearings had to be oiled separately. In the present invention the working piston is provided with piston rings very much like the pistons in the present day gasoline engine, the function of these rings being to prevent compression losses and the passage of oil.

It is a further object of this invention to provide a multiplicity of heating cylinders for each cooling cylinder in some cases, especially in the larger engines. It has been an objection that hot air engines are bulky and operate slowly. This has been true of the larger engines, but I have operated a small compact fin cooled engine with $2\frac{7}{16}$" bore at a speed of 2100 R. P. M. If the cylinder size is increased greatly, the problem of heating and cooling also increases. It may therefore be desirable to use a multiplicity of cylinders as in the present day gasoline engine rather than a single large cylinder. Because the heat absorbed by the air in the heating cylinder is limited by the conductivity of the metal of the cylinder, the present invention contemplates the use of a multiplicity of hot cylinders for each cooling cylinder in certain cases. For instance, two heating cylinders approximately $2\frac{1}{8}$" in diameter may be substituted for a heating cylinder having a diameter of 3" and the same length. The two cylinders will then have substantially the same volume as the single cylinder, but will have a greater side wall heating surface, the ratio of heating surfaces being approximately 1:1.4. If three small tubes are substituted the side wall heating ratio rises to approximately 1:1.7.

The engine may be used to drive washing machines, mechanical refrigerators, churns, etc. particularly in rural communities where electricity is expensive or not available, although any other use to which a source of power may be applied is contemplated. The particular advantage for use in the above mentioned machines is its quiet operation and lack of obnoxious fumes such as are found in small gasoline engines now commonly used for the purpose. While the engine has been described as a hot air engine, other gases may be used instead of air.

Further objects and features of the invention will be apparent from the following description taken in connection with the accompanying drawings, in which

Figure 1 is a side elevational view, partly in section, of a hot air engine embodying the principles of the invention;

Figure 2 is an end elevational view of the engine shown in Figure 1;

Figure 3 is a section taken on the line 3—3 of Figure 1;

Figure 4 is a section taken on the line 4—4 of Figure 1; and

Figure 5 is a section similar to Figure 3 of a modification of the engine shown in Figure 1.

In order to facilitate an understanding of the invention, reference will be made to the several embodiments thereof illustrated in the accompanying drawings and specific language will be employed. It will nevertheless be understood that various further modifications of the devices illustrated herein, such as would fall within the province of those skilled in the art to construct are contemplated as part of the present invention.

Referring to the drawings, the crankcase 10 supports the cooling cylinder 11 and the arcuate

transfer or heating cylinder 12, preferably formed as a segment of a tore, a flange 14 on crankcase 10 being bolted or otherwise secured to a flange 15 on the cylinder 11. Similarly, flange 16 on cylinder 11 is attached to flange 17 on the heating cylinder 12. The cooling cylinder is provided on the outside with fins 18, preferably integral with the cylinder wall. These fins are also formed on that portion of the heating cylinder 12 which lies adjacent the cooling cylinder, so as to form an almost continuous cooling surface over the whole length of the cooling cylinder and over as much as one-quarter or more of the length of the heating cylinder.

Working piston 20 may be machined as in the case of the present day gasoline engine pistons, and may be provided with one or more piston rings 21 to check loss of compression and prevent oil from the crankcase rising into the air space above the piston. Connecting rod 22 is attached by any known means, as for example by wrist pin 23 to the piston and by crank pin 24 to the crankshaft 25. Crankshaft 25 protrudes from the crankcase 10 at both ends, to one of which is attached a flywheel 28 and a pulley 29 or any other known means used to transfer the power. At the other end of crankshaft 25 is an eccentric 31, to which is pivotally attached a rod 33 by means of bearing 32. It will be noted that the eccentric bearing 32 and the crankpin 24 are disposed at an angle of 90°. Enclosing the eccentric and bolted or otherwise attached to the crankcase is a casing 34 which may contain oil to bathe the eccentric. At the point where the rod 33 emerges from the casing 34, the casing is apertured to allow for the swinging motion of the rod. Covering the aperture and tapering as it rises is a sleeve 35, preferably of leather, enclosing the rod to prevent the splashing of oil from the casing.

The transfer piston 38, which is preferably a hollow, arcuate tube closed at both ends so as to minimize weight, and conforming to the toroidal shape of the cylinder 12, is mounted on lever 39 for reciprocation in cylinder 12, clearance being provided between the piston and the cylinder wall to allow passage of the air past the piston and to eliminate friction. The wall of cylinder 12 and the sides of piston 38 therefore do not need to be perfectly machined, since there is no contact between them as in the case of the cooling cylinder 11 and power piston 20.

Again, since the transfer piston may thus be supported free from the cylinder walls, the noise resulting from operation of a loosely supported piston, characteristic of this type of engine, is minimized. The heating cylinder 12 may be constructed of two similar halves with small flanges or ears 40 for the reception of bolts 41 or other securing means.

At the base of the heating cylinder 12 is a burner plate 44 and below this and surrounding a part of the side wall is a heating chamber 45 preferably containing burners 46.

The piston operating lever 39 emerges through a slot in the cylinder wall and is keyed or otherwise rigidly attached to shaft 47 which is supported for rotation in a flanged portion 48 of the cylinder 12 and is mounted on ball bearings 49 or by other bearing means. The flange 48 protrudes outward and the bearings are located near the outer end to remove them as far as possible from the influence of the heat in the heating cylinder. Keyed or otherwise rigidly secured to one end of shaft 47 is another lever 50 (shown in outline in Figure 1) which in turn is pivotally secured to rod 33 as by means of pin 51.

A modification of the invention is shown in Figure 5 where two heating cylinders have been substituted for the heating cylinder 12. The two cylinders are made in three pieces, two similar outside walls 53 and a central wall 54 common to both. They are held together by ears 40 and bolts 41 as described hereinbefore. Flanges 56 on the cooling cylinder are larger in this case for they not only are attached to flanges 57 on the heating cylinders but provide an abutment for the transfer pistons 55 since the cross-sectional area of the two small pistons is not coincidental with the cross-sectional area of the cooling cylinder.

In the operation of the engine, as the transfer piston approaches the cooling cylinder, the air is transferred to the hot end of the heating cylinder. The working piston reaches the top of its stroke when the transfer piston is halfway in its stroke and approaching the cooling cylinder, due to the 90° angle between the crank and eccentric pin which operate the working piston and the transfer piston respectively. At this point the heated air begins to expand and forces the working piston down. When the working piston is about halfway down, the transfer piston reaches the end of its stroke and begins to approach the hot end of the heating cylinder, thus initiating the transfer of hot air to the cooling cylinder. The cooling of this hot air tends to form a slight vacuum which aids the working piston in its return stroke. The transfer piston then begins its approach to the cooling cylinder, completing the cycle.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a hot air engine, the combination with a working cylinder having a working piston therein, of a heating cylinder communicating with said working cylinder, said heating cylinder being formed as a segment of a tore, and a transfer piston operable in said heating cylinder for displacing a gaseous medium between the latter and said working cylinder.

2. In a hot air engine, the combination with a working cylinder having a working piston therein, of a heating cylinder communicating with said working cylinder, said heating cylinder being formed as a segment of a tore, and a transfer piston operable in said heating cylinder for displacing a gaseous medium between the latter and said working cylinder, said transfer piston being arcuate in form to conform to the configuration of said heating cylinder, and means supporting said transfer piston for swinging movement about an axis coincident with the axis of said tore.

3. In a hot air engine, the combination with a working cylinder having a working piston therein, of a plurality of arcuate heating cylinders formed as segments of tores communicating with said working cylinder, and means associated with said heating cylinders for displacing a gaseous medium between said heating cylinders and said working cylinder.

THEODORE F. THOMPSON.